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Patterns of Dental Service Utilization Following Nontraumatic Dental Condition Visits To the Emergency Department in Wisconsin Medicaid

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Abstract

Objectives: To examine patterns of dental service utilization for adult Medicaid enrollees in Wisconsin following nontraumatic dental condition (NTDC) visits to the emergency department (ED).

Methods: This is a retrospective, observational study of claims for NTDC visits to the ED and dental service encounters from the Wisconsin Medicaid Evaluation and Decision Support database (2001–2009). We used competing risk models to predict probabilities of returning to the ED versus obtaining follow-up care from a dentist.

Results: We observed a 43 percent increase in the rate of NTDC visits to the ED, with most of this increase occurring from 2001 to 2005. Within 30 days of an NTDC visit to the ED, ~29.6 percent of enrollees will first visit a dentist office, while ~9.9 percent will return to the ED. Young to middle-aged adults (18 to <50 years) and enrollees living in counties with a lower supply of dental providers were more likely to return to the ED following a NTDC visit. Among the enrollees that first visited a dental office following an ED visit, 37.6 percent had an extraction performed at this visit.

Conclusions: Almost one in five adult Medicaid enrollees will subsequently return to the ED following a previous NTDC visit. The provision of definitive care for these individuals appears to primarily consist of extractions.

Keywords: dental health services, dental care, emergency service, hospital, Medicaid

Introduction

Due to financial barriers, health literacy issues (1), and limited participation by dentists (2), individuals covered by public programs (e.g., Medicaid) encounter consistent difficulty accessing oral health care. Inadequate access to appropriate dental care presumably drives some individuals to seek care for nontraumatic dental conditions (NTDC) in emergency departments (EDs). Although ED visits for dental care account for a small proportion of all ED visits (3), recent reports suggest an increasing rate of NTDC visits to EDs (4–6). In addition, a recent study from Ontario reported that ED visits for dental care actually outnumbered visits for common health problems such as diabetes and hypertension between 2003 and 2006 (7). NTDC visits to EDs incur expensive charges for treatments that are unlikely to be definitive, usually entailing a prescription for antibiotics/analgesics and a referral to see a dentist (8).

Cohen *et al.* indicated that individuals visiting EDs for dental problems expect that they will eventually need to receive care from a dental provider (1). However, the Cohen *et al.* study did not strictly focus on individuals enrolled in Medicaid, a population that faces significant barriers to accessing oral health care compared with the privately insured. This leaves open the question of how often Medicaid enrollees are actually able to obtain follow-up dental care. In a recent telephone survey of Illinois dental providers (concerning the hypothetical scenario of a 10-year-old boy seeking emergency care for

oral injury), 36.5 percent of individuals indicating coverage through Medicaid were able to schedule an appointment with a dentist, compared with 95.4 percent for those indicating coverage through Blue Cross-Blue Shield (9). Although this study dealt with acute oral injury and not NTDCs, it clearly demonstrates the difficulty public program enrollees experience in obtaining appropriate dental care.

Recently, our group investigated the issue of recurrent utilization of EDs and physician offices for NTDCs using Medicaid claims data from the state of Wisconsin from 2001 to 2003 (10). We found that 6.0 percent of those that made at least one NTDC visit repeatedly visited EDs or nonemergency settings at an average visit rate of 4 per year. In this current study, we expand this work on NTDC visits among Wisconsin Medicaid enrollees to include an additional 6 years of claims data through the end of the 2009 calendar year. The goals of the present study are to examine patterns of dental service utilization following NTDC visits to EDs, in order to estimate the likelihood that Medicaid enrollees receive follow-up care from a dentist or subsequently return to the ED. As a secondary aim, we investigated temporal trends in ED utilization for NTDCs among Wisconsin Medicaid enrollees.

Methods

Data source

Data for this study was extracted from the Wisconsin Medicaid Evaluation and Decision Support (MEDS) database (inclusive dates: 1/1/2001 through 12/31/2009) which is managed by the Division of Health Care Access and Accountability, Wisconsin Department of Health Services. We obtained three separate data files that included all claims for NTDC visits to EDs, all claims for service encounters submitted by dentists, and data defining periods of enrollment (either in a fee-for-service program or through a managed care organization) for the entire Wisconsin Medicaid population. All claims with the same date of service were merged together as a single visit. Each enrollee was assigned a unique, random proxy ID prior to data extraction by the state Medicaid office. This proxy ID was then used to link claims from different service encounters and calculate periods of enrollment.

As in our previous studies, we defined NTDC visits based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code supplied for the primary diagnosis (10,11). Claims associated with ED visits were identified through internal revenue codes used within the MEDS database.

Demographic and county-level variables

Previous analyses (12), including our prior work with the Wisconsin Medicaid population (10), have indicated that adult enrollees account for the majority of NTDC visits to the ED. For the present study, we have therefore focused on adult enrollees (classified as 18 to 30 years, 30 to 50 years, 50 to 70 years, and 70 years and older). In Wisconsin, benefits for adult Medicaid enrollees cover all dental service categories (Exams, Preventive services, Basic restorative services, Advanced restorative services, Periodontal services, Dentures, and Oral surgery services) (13,14). Additional demographic information linked to each proxy ID included sex, race/ethnicity (reported as White, Black, Hispanic, American Indian/Alaskan Native, Asian, Other Race/Ethnicity, or not reported), and ZIP code of residence.

Based on the ZIP code of residence, we constructed two county-level classification variables for each enrollee, the 2003 Urban Influence Codes (UIC; metropolitan, micropolitan, or noncore/rural), and the low-income population to dentist full-time equivalent (FTE) ratio (3,000:1 to 3,999:1, 4,000:1 to 7,999:1, 8,000:1 to 19,999:1, and $\geq 20,000:1$). UICs, which are computed by the US Department of Agriculture based on commuting and census data, were used as a measure of rurality for each county (<http://www.ers.usda.gov/briefing/rurality/urbaninf/>). The dentist FTE ratio (which is used in designating Dental Health Professional Shortage Areas) represents a population to provider ratio, comparing the size of the low-income population to number of FTE dentists submitting Medicaid claims in 2007 (http://www.dhs.wisconsin.gov/health/primarycare/docs/DentistFTE_LIPopRatio_w_defs1209.pdf). It is important to note that no counties in Wisconsin met the minimum federal recommendation of a 3,000:1 ratio or lower, while 69 of 72 counties had ratios surpassing the

federal threshold for designating a dental provider shortage area ($\geq 4,000:1$).

Statistical analyses

The dataset included claims for 99,174 NTDC visits to EDs. After removing visits from enrollees under 18 years of age and those from enrollees with missing enrollment information, we were left with a total of 86,893 visits in the present analysis. Because Medicaid enrollment can change on a month-to-month basis, we calculated rates of NTDC visits to EDs relative to the number of person-years of enrollment using Poisson models (allowing for over-dispersion). For each year, we also calculated the proportion of enrollees (among those enrolled for the entire year) that made at least one NTDC visit to the ED or dental office. We also further classified dental office visits based on their associated Current Dental Terminology (CDT) codes for preventive (D1110 through D1555), restorative (D2110 through D2999), and extraction/surgical (D7110 through D7999) procedures.

Modeling patterns of utilization after NTDC visits to the ED

We modeled the time until and the site (dental office or ED) of the next service encounter for each enrollee following an index NTDC visit using a competing risks approach. We considered a time horizon of 12 months following the index visit assuming two causes of "failure" (first follow-up visit to a dentist ($j = 1$) or to the ED ($j = 2$)) and the presence of right-censoring (no subsequent claims following the index visit within 12 months). We modeled the cause-specific cumulative incidence function $P_j(t; x)$, which represents the instantaneous probability at time t that the first case of follow-up dental care will occur in setting j conditional on a set of covariates x . We used a class of additive regression models parameterized as

$$-\log[1 - P_j(t; x)] = x^T \alpha(t),$$

where $\alpha(t)$ represents a set of unknown regression coefficients ([15](#)). Note that $\alpha(t)$ is a function of time, thus the effect of each covariate is

allowed to be time-varying in all models. These models were implemented within the *timereg* package ([16](#)) for the R Statistical Computing Environment. The significance of each covariate was tested using a resampling procedure based on 5,000 samples ([17](#)). Because we focused on a restricted time horizon following an index NTDC visit to the ED (12 months), enrollees can contribute multiple observations to the analysis due to visits greater than 12 months apart. We included subject-specific random effects to account for correlations induced by such enrollees with multiple visits ([18](#)). Unless otherwise mentioned, all analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC, USA). This study was approved by the Institutional Review Boards of Wake Forest University Health Sciences and Marquette University.

Results

The size of the enrolled adult Medicaid population in Wisconsin grew by 112 percent from 2001 to 2009, increasing from 210.95 to a total of 446.45 thousand person-years ([Table 1](#)). The rate of NTDC visits to the ED exhibited a similar pattern of growth, increasing 43 percent from 22.60 visits per 1,000 person-years in 2001 to 32.33 visits per 1,000 person-years in 2009. The rate of NTDC visits could be sensitive to enrollees making multiple visits; therefore we also calculated the proportion of enrollees with at least one NTDC visit to the ED, restricted to individuals that were enrolled for the entirety of each given year. In 2001, 0.9 percent of enrollees made at least one NTDC visit to the ED, with the proportion reaching 2.2 percent in 2009. We observed a similar pattern of growth for dental office visits and visits entailing either preventive or restorative procedures, with increases in the proportion of enrollees with at least one visit from 2001 to 2004, then remaining stable from 2005 to 2009.

Table 1: Longitudinal Trends in Nontraumatic Dental Condition (NTDC) Visits to Emergency Departments (ED) and Dental Visits (DV) by Adult Wisconsin Medicaid Enrollees (2001–2009)

Year	ED Visits				DV		
	N _{ED}	PY	Rate (95% CI)	% with ED visit*	% with any DV*	% with preventive DV*	% with restorative DV*
2001	4,754	210.39	22.60 (20.46-24.96)	0.009	0.159	0.074	0.051
2002	6,810	295.92	23.01 (21.12-25.07)	0.016	0.212	0.103	0.075
2003	7,988	321.50	24.85 (22.79-27.08)	0.017	0.283	0.144	0.104
2004	8,774	336.57	26.07 (23.96-28.37)	0.017	0.322	0.171	0.117
2005	9,360	341.17	27.43 (25.39-29.65)	0.019	0.307	0.164	0.110
2006	10,920	345.64	31.59 (29.01-34.41)	0.021	0.303	0.163	0.110
2007	11,805	350.29	33.70 (31.17-36.44)	0.022	0.309	0.167	0.112
2008	12,046	367.45	31.09 (28.47-33.95)	0.021	0.312	0.167	0.117
2009	14,436	446.45	32.33 (29.62-35.30)	0.022	0.314	0.167	0.116

* Proportion of enrollees with at least one visit in a given year, restricted to enrollees enrolled for the entire year.

CI, confidence interval; N_{ED}, count of NTDC ED visits; PY, person-years of enrollment (in thousands); RATE, rate of NTDC ED visits per 1,000 person-years of enrollment.

Table 2 displays the rate of NTDC visits to the ED stratified by demographic and county-level variables, based on two time periods, 2001–2005 and 2006–2009. In general, almost all of the subgroups examined exhibited an increased rate of NTDC visits to the ED between 2001–2005 and 2006–2009 (driven by increases between 2001 and ~2004), with the exception of black enrollees. The strongest gradient in the rate of NTDC visits to the ED was across age, with 18- to 30-year-olds having a rate of 54.08 visits per 1,000 person-years (2005–2009) compared with 0.80 per 1,000 person-years among those 70 years of age or older. We did not observe any large differences across the dentist FTE ratio categories based on county of residence. Enrollees residing in urban (metropolitan) counties displayed the highest rate of NTDC visits to the ED in both time periods, with those living in rural counties displaying the lowest rate.

Table 2: Rates of Nontraumatic Dental Condition (NTDC) Visits to Emergency Departments (ED) by Adult Wisconsin Medicaid Enrollees According to Individual and County-Level Demographic Characteristics

	2001 to 2005			2006 to 2009			RR
	N _{ED}	PY	Rate (95% CI)	N _{ED}	PY	Rate (95% CI)	
Sex							
Female	27,412	1,026.58	26.70 (24.70-28.86)	34,983	1,028.87	34.00 (31.46-36.74)	1.27*
Male	10,274	478.97	21.45 (19.57-23.52)	14,224	500.97	28.39 (26.11-30.88)	1.32*
Age							
18 to less than 30 years	19,042	440.08	43.27 (40.37-46.38)	25,775	476.63	54.08 (50.07-58.40)	1.25*
30 to less than 50 years	16,683	576.99	28.91 (26.63-31.40)	20,364	598.98	34.00 (31.39-36.82)	1.18
50 to less than 70 years	1,835	238.89	7.68 (6.84-8.62)	2,913	260.78	11.17 (9.90-12.60)	1.45*
70 years or more	126	249.59	0.50 (0.40-0.64)	155	193.44	0.80 (0.66-0.98)	1.59*
Race/ethnicity							
White	20,695	902.14	22.94 (21.04-25.01)	30,713	940.31	32.66 (29.96-35.61)	1.42*
Black	9,269	234.00	39.61 (37.81-41.5)	9,078	237.95	38.15 (35.21-41.33)	0.96
Hispanic	1,500	71.31	21.03 (19.12-23.14)	2,370	87.24	27.17 (25.16-29.33)	1.29*
American Indian/Alaskan Native	896	20.57	43.55 (37.61-50.44)	1,342	23.14	57.99 (51.46-65.35)	1.33*
Asian†	114	36.64	3.11 (2.57-3.77)	197	43.87	4.49 (3.61-5.58)	1.44
Other	249	7.79	31.97 (25.85-39.54)	375	9.76	38.41 (32.81-44.95)	1.20
Not provided	4,963	233.10	21.29 (19.44-23.32)	5,132	187.55	27.36 (24.74-30.26)	1.29*
Low income population to dentist FTE ratio							
3,000:1 to 3,999:1	13,421	446.66	30.05 (25.66-35.18)	13,218	430.82	30.68 (28.59-32.92)	1.02
4,000:1 to 7,999:1	6,180	272.29	22.70 (19.40-26.55)	7,615	281.58	27.04 (23.86-30.65)	1.19
8,000:1 to 19,999:1	13,827	582.12	23.75 (20.86-27.05)	22,111	607.09	36.42 (31.62-41.95)	1.53*
≥20,000:1	4,258	204.49	20.82 (16.89-25.66)	6,263	210.35	29.77 (25.93-34.19)	1.43*
Urban Influence Code							
Metropolitan	28,513	1,053.27	27.07 (24.28-30.19)	36,233	1,070.75	33.84 (30.03-38.13)	1.25
Metropolitan	4,297	184.00	23.35 (18.25-29.88)	6,081	192.73	31.55 (25.62-38.86)	1.35
Noncore/rural	4,876	268.28	18.18 (16.07-20.55)	6,893	266.35	25.88 (22.86-29.29)	1.42*

*P < 0.05.

† Race/ethnicity reported as Asian, Pacific Islander, or Native Hawaiian.

CI, confidence interval; FTE, full-time equivalent; N_{ED}, count of NTDC ED visits; PY, person-years of enrollment (in thousands).

Figure 1a displays the estimated cumulative incidence curves representing the probability of first visiting a dental office or the ED following an index NTDC visit to the ED. Within 30 days of the index visit, 29.6 percent [standard error (SE) = 0.2 percent] of enrollees first visited a dental office, while 9.9 percent (SE = 0.1 percent) first returned to the ED (60.5 percent did not have a subsequent claim within that time frame). Considering a longer time interval of 180 days, 41.5 percent (SE = 0.2 percent) of enrollees first visited a dentist, 18.3 percent (SE = 0.2 percent) returned to the ED, while 40.1 percent had no subsequent dental claims. In **Table 3**, we examined the CDT codes associated with dental office visits representing the first encounter following a NTDC visit to the ED. Other than codes for diagnostic procedures, the most prevalent codes observed were tied to surgical/extraction procedures (37.6 percent of visits).

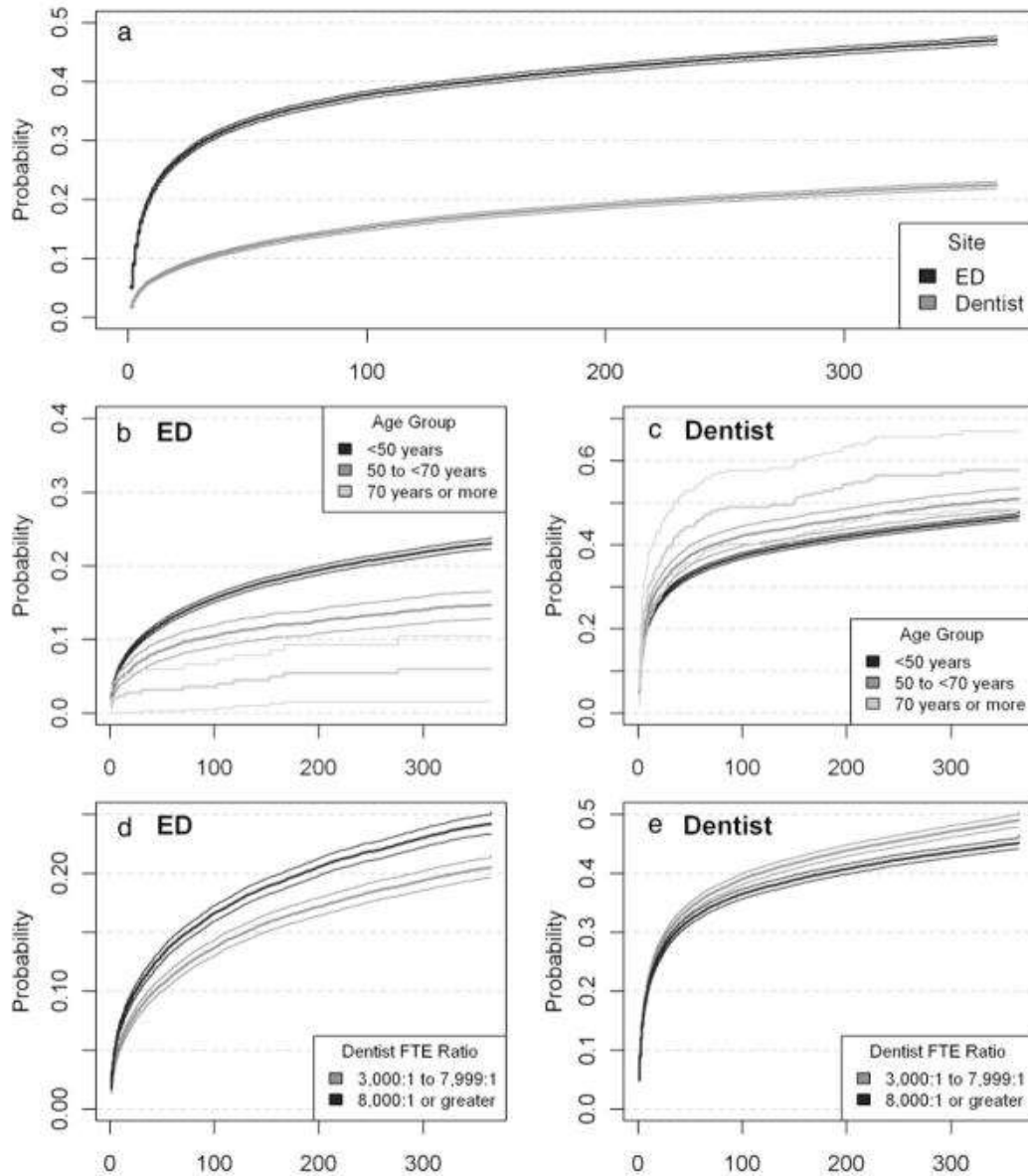


Figure 1: Predicted cumulative incidence curves for the first site of dental care following a nontraumatic dental condition visit to the emergency department (ED). (a) Bold lines denote the estimated cumulative incidence curves for the entire adult Wisconsin Medicaid population with estimated 95 percent confidence bands. Lower plots denote marginal cumulative incidence curves for emergency department visits (b,d) and dentist visits (c,e) stratified by age group and the low-income population to dentist full-time equivalent (FTE) ratio based on county of residence (see Methods).

Table 3: Dental Services Received for Dental Visits Following Index Nontraumatic Dental Condition Visits to the Emergency Departments Based on Current Dental Terminology (CDT) Codes

CDT code category	CDT code range	n (%)
Diagnostic	D110 to D1000	20,893 (0.845)
Preventive	D1110 to D1555	2,416 (0.098)
Restorative	D2110 to D2999	2,147 (0.087)
Endodontics	D3110 to D3999	566 (0.023)
Periodontics	D4210 to D4999	364 (0.015)
Prosthodontics (removable)	D5110 to D5899	188 (0.008)
Maxillofacial Prosthetics	D5911 to D5999	0 (0.000)
Implant Services	D6010 to D6199	0 (0.000)
Prosthodontics (fixed)	D6205 to D6999	7 (<0.001)
Oral and Maxillofacial Surgery	D7110 to D7999	10,110 (0.409)
Extraction	D7111, D7120, D7130, D7140, D7210, D7220, D7230, D7240, D7241, and D7250	9,296 (0.376)
Orthodontics	D8010 to D8999	7 (<0.001)
Adjunctive General Services	D9110 to D9999	4,406 (0.178)

Analysis includes 24,723 index visits which were first followed by a dentist visit within 12 months.

We also considered the impact of demographic/county-level variables on the estimated probabilities for the first site of dental care following a NTDC visit to the ED. Due to the large available sample size, most of the factors considered displayed significant associations ([Supporting Information Figures S1 and 2](#)), though the strongest effects were generally attributable to age, living in a rural county, or living in a county with a shortage of dental providers (based on the dentist FTE ratio for the county of residence). [Figures 1b and 1c](#) illustrate the marginal effect of age on the cumulative incidence curves. For the purposes of illustration, we have collapsed the age categories of 18 to <30 years and 30 to <50 years as there was little indication of a difference between these groups. Young to middle age enrollees (18 to <50 years) accounted for the majority of index NTDC visits (94.2 percent), were the least likely to first visit a dentist, and thus more likely to subsequently return to the ED. For example, 10.1 percent (SE = 0.1 percent) of 18- to <50-year-olds, 7.2 percent (SE = 0.5 percent) of 50- to <70-year-olds, and 3.1 percent (SE = 1.0 percent) of adults 70 years or older first returned to the ED within 30 days of the index visit. At 180 days, the probabilities of first visiting the ED across these age categories correspondingly increased to 18.8 percent

(SE = 0.1 percent), 12.1 percent (0.6 percent), and 5.4 percent (SE = 1.4 percent), respectively. [Figures 1d and 1e](#) present similar marginal estimates based on the low-income population to dentist FTE ratio for each enrollee's county of residence. Enrollees that reside in counties with a ratio at or below 7,999:1 had a probability of 8.8 percent (SE = 0.2 percent) of returning to the ED within 30 days, compared with 10.9 percent (SE = 0.2 percent) for enrollees living in counties with a ratio greater than or equal to 8,000:1. In terms of the other demographic factors, female gender and Hispanic ethnicity (compared with whites) were associated with higher probabilities of first visiting the dentist following an NTDC visit to the ED, and thus also with lower probabilities of returning to the ED. Compared with white enrollees, blacks were less likely to first visit the dentist, with higher probabilities of first returning to the ED.

Discussion

Overall, we found that the rate of NTDC visits to EDs has generally increased, in spite of a corresponding increase in the proportion of enrollees with dental office visits. However, much of this increase was observed between 2001 and 2005, with very little further increase from 2006 to 2009. Increased utilization of EDs for dental care has been reported in several recent studies of both children and adults ([5-7](#)). However, our data suggest that the rate of NTDC visits has largely leveled off for adults in Wisconsin Medicaid. This observation is consistent with recent data from New York State concerning early childhood caries (ECC)-related visits to EDs and ambulatory surgery facilities ([19](#)). In that study, the number of ECC-related visits was fairly constant over time for children covered under Medicaid, with most of the observed increase being driven by uninsured (self-pay) children. While our data do not indicate further expansion in the rate of NTDC visits after 2006, projecting this result into the future assumes that there are no subsequent cuts to dental coverage for adults. Recent data from Oregon illustrated that enrollees who lost dental coverage subsequently displayed an increase in the use of ED and non-ED ambulatory medical settings for dental care ([20](#)). Similar results were observed in Maryland in 1993, where the elimination of coverage for dental emergencies led to a 21.8 percent increase in dental-related ED visits ([21](#)).

Based on telephone interviews conducted in Maryland, Cohen and his colleagues have reported that the majority of individuals visiting the ED for toothache-related pain have an expectation of eventually needing to seek care from a dental provider, and that the majority of individuals do in fact contact a dentist following an ED visit ([1,22](#)). However, these studies were designed to be representative of the entire population in Maryland, and not strictly focused on public program participants. Our data suggest that many adult Medicaid enrollees in Wisconsin do not obtain follow-up care with a dental provider, particularly for young to middle-aged adults and enrollees living in areas described as having higher dental provider shortage. We estimated that almost one in five (18.3 percent) of enrollees will return to the ED within 180 days prior to visiting a dental office. This suggests that limiting recurrent use could be a reasonable interventional target moving forward. One means to limit recurrence would be the provision of definitive care (i.e., performing extractions) within the ED, or perhaps by providing primary dental care within the setting of an emergency dental clinic. While the desirability and efficiency of such approaches is certainly debatable, there is a substantial need for interventions that improve access to treatment for those with existing dental disease.

We observed a significantly higher rate of NTDC visits to the ED among Native American Medicaid enrollees compared with white enrollees. This higher rate of ED utilization is consistent with our prior studies in Wisconsin Medicaid ([11](#)), and could be related to oral health literacy issues. Lee *et al.* recently reported lower oral health literacy among Native Americans compared with whites in North Carolina, even after adjusting for socioeconomic and educational differences ([23](#)). In contrast, Native Americans were not significantly different from whites in terms of their dental service utilization following NTDC visits to the ED. Blacks were the lone subgroup that did not exhibit an increase in the rate of NTDC visits to the ED over time. Yet, compared with whites, blacks had a higher overall rate of NTDC visits, and were significantly more likely to first return to the ED (less likely to follow up with a dental office visit). Based on our data, there is not a clear explanation for this lack of increase in ED utilization for black enrollees.

Program and policy implications

Recent Medicaid policies concerning oral health have particularly focused on the prevention of ECC, such as allowing medical providers to be reimbursed for the provision of fluoride varnish treatment (24,25). While this focus on ECC is entirely justified, our data and previous studies of ED utilization for NTDC highlight a parallel need to address dental care for adult public program enrollees. Unfortunately, appropriate policies and interventions that could address the dental needs of this population are not immediately apparent. While preventive strategies certainly should be promoted, they will do little to address existing disease in the short term, thereby placing a premium on access to primary care. The most frequently cited barriers for dentist participation in Medicaid include low reimbursement, a large administrative burden, and business disruptions caused by missed appointments. While there is recent data to suggest that increasing reimbursement may lead to improvements in dental service utilization (26), such increases are unlikely in the current fiscal environment, with cuts to adult dental coverage being a more likely possibility. Similarly, requiring/increasing co-payments for nonurgent care received in the ED seems unlikely to curb utilization driven by dental problems (27). This suggests that continued research is necessary to develop interventional strategies that will lead to improved access to care for adults covered under Medicaid. These efforts could capitalize on a recent research agenda proposed for addressing frequent ED utilization (28), including the development of uniform surveillance measures for NTDC visits to the ED. Finally, while we have not focused on cost as part of this study, the cost-effectiveness of any proposed intervention certainly warrants attention. For example, hypothetical estimates generated by Quiñonez *et al.* indicated that universal dental coverage for adults in Canada (as a means of improving access to care) was unlikely to be cost-effective from a purely financial perspective, as large implementation costs would not be offset by the modest savings of preventing NTDC visits to the ED (12).

Limitations

Analyses of the National Hospital Ambulatory Medical Care survey have indicated that Medicaid enrollees account for ~25 percent

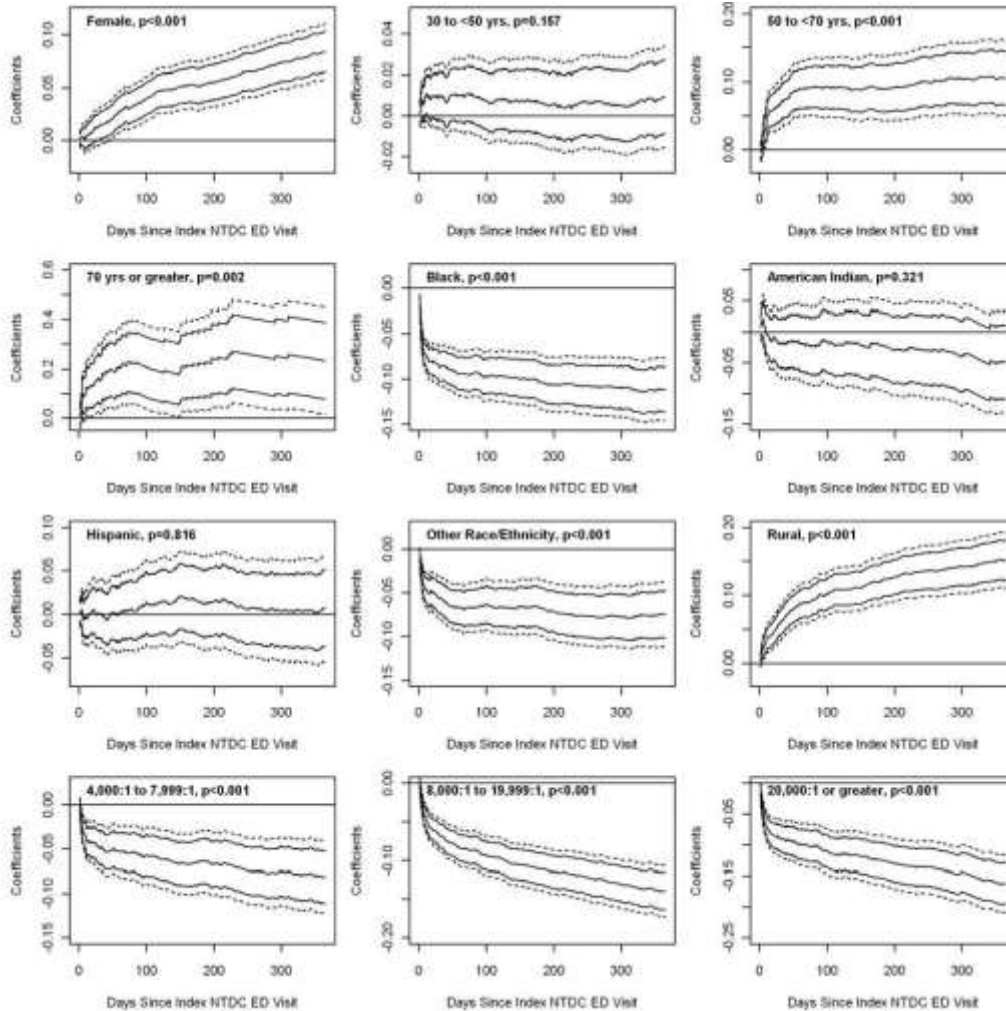
of NTDC visits to the ED ([29](#)). Our study invariably does not capture the full spectrum of ED utilization for dental care, including visits by self-pay individuals or the privately insured. However, our focus on Medicaid enrollees does provide the advantage of linking ED utilization with claims from dental providers over an extended period of follow-up. The use of claims data also does not allow us to comment on the underlying motivation for seeking dental care in an ED. For the sake of clarity, we have also chosen to focus on NTDC visits to EDs, leaving out utilization of other medical settings such as physician's offices.

Conclusions

Our results highlight a substantial increase in the size of Wisconsin Medicaid enrolled population and an increase in NTDC visits to the ED, in spite of concurrent increases in the utilization of oral health care provided by dentists. Our data also suggest that many Wisconsin Medicaid adult enrollees do not visit a dental office following dental-related ED visits, leading to recurrent ED utilization. Improved access to dental care for Medicaid adult enrollees could have the potential to reduce this problem. While the rate of NTDC visits to the ED appears to have stabilized in Wisconsin, future decreases in adult dental coverage by Medicaid could exacerbate this problem and increase utilization of medical settings for dental care.

Supplementary Material

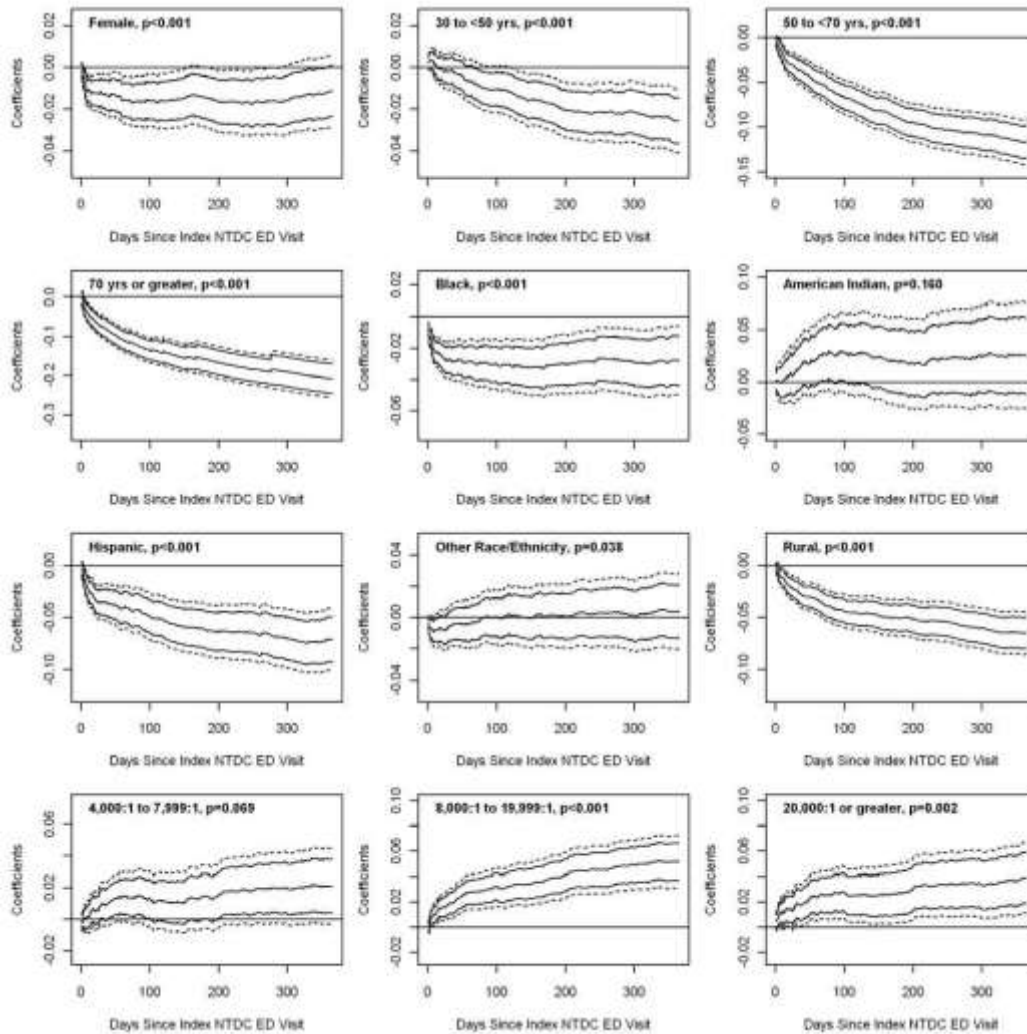
Figure S1 Estimates of time-varying effects based on a multivariable regression model for the probability of first visiting a dental office following a nontraumatic dental condition (NTDC) visit to the emergency department (ED).



Curves denote the time-varying regression coefficients $\alpha(t)$ with point-wise 95 percent confidence intervals (solid lines) and 95 percent confidence bands (dashed lines). Positive coefficients indicate an increased incidence of first visiting a dental office following a NTDC visit to the ED, with negative coefficients conversely indicating a decreased incidence. The reference category for the above coefficient

estimates is a white male, between the ages of 18 and <30 years, living in a metropolitan/micropolitan county with low-income population to dentist full-time equivalent ratio based on county of residence between 3,000:1 and 3,999:1 (see Methods).

Figure S2 Estimates of time-varying effects based on a multivariable regression model for the probability of first returning to the emergency department (ED) following a nontraumatic dental condition (NTDC) visit to the ED.



Curves denote the time-varying regression coefficients $\alpha(t)$ with point-wise 95 percent confidence intervals (solid lines) and 95 percent confidence bands (dashed lines). Positive coefficients indicate an

increased incidence of first returning to the ED following a NTDC visit to the ED, with negative coefficients conversely indicating a decreased incidence. The reference category for the above coefficient estimates is a white male, between the ages of 18 and <30 years of age, living in a metropolitan/micropolitan county with a low-income population to dentist full-time equivalent ratio based on county of residence between 3,000:1 and 3,999:1 (see Methods).

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